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MAURICE RIVER BASIN
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GLOUCESTER COUNTY
NEW JERSEY

LAKE GARRISON DAM
NJ00778

DACW61-79-C-0011

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

REPT. NO: DAEN/NAP-53842/NJ00778-81/07

JULY 1981

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

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Embankments
Visual Inspection
Structural Analysis
National Dam Safety Program
Lake Garrison Dam, NJ
Spillways

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-N

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

20 JUL 1981

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Lake Garrison Dam, Gloucester County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Lake Garrison Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in good overall condition. The dam's spillway is considered inadequate because a flow equivalent to 19 percent of the Spillway Design Flood (SDF) would cause the dam to be overtopped. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures and studies within six months from the date of approval of this report. Within three months of the consultant's findings remedial measures to ensure spillway adequacy should be initiated.

b. Within six months from the date of approval of this report the following remedial actions should be initiated:

(1) The rusted condition of outlet works, operating mechanisms and steel sheet piling should be repaired.

(2) Erosion of the embankment adjacent to the downstream right abutment should be properly filled and stabilized.

(3) All trees and adverse vegetation on the embankment should be removed.

c. The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam, within one year from the date of approval of this report.

d. An emergency action plan and warning system should be developed which outlines actions to be taken by the owner to minimize the downstream effects of an emergency at the dam within six months from the date of approval of this report.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Florio of the First District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Inspection Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

ROGER L. BALDWIN
Lieutenant Colonel, Corps of Engineers
Commander and District Engineer

1 Incl
As stated

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Regulation
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

LAKE CARRISON DAM (NJ00778)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 9 January 1981 by Storch Engineers, under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Lake Garrison Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in good overall condition. The dam's spillway is considered inadequate because a flow equivalent to 19 percent of the Spillway Design Flood (SDF) would cause the dam to be overtopped. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures and studies within six months from the date of approval of this report. Within three months of the consultant's findings remedial measures to ensure spillway adequacy should be initiated.

b. Within six months from the date of approval of this report the following remedial actions should be initiated:

(1) The rusted condition of outlet works, operating mechanisms and steel sheet piling should be repaired.

(2) Erosion of the embankment adjacent to the downstream right abutment should be properly filled and stabilized.

(3) All trees and adverse vegetation on the embankment should be removed.

c. The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam, within one year from the date of approval of this report.

d. An emergency action plan and warning system should be developed which outlines actions to be taken by the owner to minimize the downstream effects of an emergency at the dam within six months from the date of approval of this report.

APPROVED: Roger Baldwin

ROGER L. BALDWIN
Lieutenant Colonel, Corps of Engineers
Commander and District Engineer

DATE: 20 July 81

PHASE I REPORT
NATIONAL DAM SAFETY REPORT

Name of Dam:	Lake Garrison Dam, I.D. NJ00778
State Located:	New Jersey
County Located:	Gloucester
Drainage Basin:	Maurice River
Stream:	Reed Branch of Still Run
Date of Inspection:	January 9, 1981

Assessment of General Condition of Dam

Based on visual inspection, past operational performance and Phase I engineering analyses, Lake Garrison Dam is assessed as being in good overall condition.

Based on investigations of the downstream flood plain made in connection with this report, it is recommended that the hazard potential classification be downgraded from high to significant hazard.

Hydraulic and hydrologic analyses indicate that the spillway is inadequate. Discharge capacity of the spillway is not sufficient to pass the designated spillway design flood (100-year storm) without an overtopping of the dam. The spillway is capable of passing approximately 19 percent of the spillway design flood. Therefore, the owner should engage a professional engineer experienced in the design and construction of dams in the near future to perform more accurate hydraulic and hydrologic analyses relating to spillway capacity. Based on the findings of the analyses, the need for and type of remedial measures should be determined and then implemented.

The owner should, in the near future, develop an emergency action plan together with an effective warning system outlining actions to be taken by the operator to minimize downstream effects of an emergency at the dam.

In addition, it is recommended that the following remedial measures be undertaken by the owner in the near future.

1) The rusted condition of the outlet works and steel sheet piling should be repaired.
2) Erosion of the embankment adjacent to the downstream right abutment should be properly filled and stabilized.
3) All trees and adverse vegetation on the embankment should be removed.

In the future, the owner of the dam should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

Richard J. McDermott, P.E.

John E. Gribbin, P.E.

OVERVIEW - LAKE GARRISON DAM

31 JANUARY 1981

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that the unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydraulic and hydrologic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydraulic and hydrologic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

LAKE GARRISON DAM, I.D. NJ00778

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspections throughout the United States. The Division of Water Resources of the New Jersey Department of Environmental Protection (NJDEP) in cooperation with the Philadelphia District of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the State of New Jersey. Storch Engineers has been retained by the NJDEP to inspect and report on a selected group of these dams. The NJDEP is under agreement with the Philadelphia District of the Corps of Engineers.

b. Purpose of Inspection

The visual inspection of Lake Garrison Dam was made on January 9, 1981. The purpose of the inspection was to make a general assessment of the structural integrity and operational adequacy of the dam structure and its appurtenances.

1.2 Description of Project

a. Description

The dam consists of an earth embankment with a spillway structure located near the center. The spillway structure consists of a

horseshoe-shaped interlocking steel sheet pile weir located on the upstream side of the embankment with primary and secondary spillway crests. The spillway discharge channel is formed by a continuation of the sheet piling through the embankment. At the downstream end of the discharge channel a low weir, formed by sheet piling, impounds a stilling basin for the spillway.

The outlet works consists of two gated 2' x 3' sluices which are located at the right and left ends of the interlocking steel sheet piling forming the spillway weir.

The upstream face of the dam is formed by a treated timber bulkhead. The top width of embankment is 18 feet and the downstream slope is approximately 4 horizontal to 1 vertical.

The elevation of the primary spillway crest is 108.7, National Geodetic Vertical Datum (N.G.V.D.) and that of the secondary spillway crest is 109.0. The crest of dam is at elevation 110.6. The elevation of the invert of the right outlet works is 106.8 and the invert of the left outlet works is 105.5, while that of the channel bed is 103.8. The overall length of the dam is 500 feet and its height is 6.8 feet.

b. Location

Lake Garrison Dam is located in Elk Township, Gloucester County, New Jersey. It impounds a private recreational lake located adjacent to Gloucester County Route 553. Principal access to the dam is by Route 553 located immediately downstream from the dam. Discharge from the spillway of the dam flows into the Reed Branch of Still Run.

c. Size and Hazard Classification

The dam is classified in accordance with criteria presented in "Recommended Guidelines for Safety Inspection of Dams" published

by the U.S. Army Corps of Engineers. Size categories consist of Small, Intermediate and Large while hazard categories are designated as Low, Significant and High.

Size Classification: Lake Garrison Dam is classified as "Small" size since its maximum storage volume is 152 acre-feet (which is less than 1000 acre-feet) and its height is 6.8 feet (which is less than 40 feet).

Hazard Classification: Visual inspection of the downstream flood plain of the dam indicates that failure of the dam could damage the roadway of Gloucester County Route 553 located about 200 feet downstream from the dam. It is not anticipated that dam failure during a storm equivalent to the SDF would cause excessive damage to the four dwellings located along the toe of dam and a few lives could be lost. Accordingly, Lake Garrison Dam is classified as "Significant" hazard.

d. Ownership

Lake Garrison Dam is owned by Lake Garrison, Inc., Route 553, Monroeville, New Jersey 08343.

e. Purpose of Dam

The purpose of the dam is the impoundment of a private recreational lake facility.

f. Design and Construction History

Reportedly, the present horseshoe-shaped steel sheet pile spillway structure at Lake Garrison Dam was constructed around 1958, replacing the old timber spillway. This spillway modification was initiated because of the flood of September 1, 1940 which reportedly overtopped the dam embankment. Initial requests for spillway modification were made immediately

following the flood of September 1, 1940 by the owner to increase spillway capacity. These requests were denied by the State until the downstream bridge, (Route 553) originally constructed in 1924, could be modified to carry the additional flow. The work was accomplished by the Lake Garrison, Inc. in accordance with plans entitled "Plans for Proposed Reconstruction of Spillway at Lake Garrison" dated August 1958 prepared by Frederick H. McClennen, P.E. and L.S.

Reportedly, no records or plans for the construction of the original dam are on file. The original dam was referred to as Monroeville Lake Dam.

g. Normal Operational Procedures

The dam and appurtenances are maintained by the owner, Lake Garrison, Inc. There is no fixed schedule of maintenance; repairs are made as the need arises.

Reportedly, during the summer months, since the lake is used as a recreational facility, the water quality is tested twice weekly.

The outlet works has been used to partially drain the lake for lake maintenance purposes. The lake was last drawn down in September 1980 and was in a drawndown condition during our inspection.

1.3 Pertinent Data

a.	Drainage area	7.0 square miles

b. Discharge at Damsite

Maximum flood at damsite	September 1, 1940 (Dam embankment overtopped) Inflow quantity unknown.
Outlet works at pool elevation	41 c.f.s.
Spillway capacity at top of dam	614 c.f.s.

c. Elevation (N.G.V.D.)

Top of Dam	110.6
Maximum pool-design surcharge	111.9
Recreation pool	108.8
Primary spillway crest	108.7
Secondary spillway crest	109.0
Stream bed at centerline of dam	103.8
Maximum tailwater	106 (Estimated)

d. Reservoir

Length of maximum pool	2400 feet (Estimated)
Length of recreation pool	2300 feet (Scaled)

e. Storage (Acre-feet)

Recreation pool	89
Design surcharge	235
Top of dam	152

f. Reservoir Surface (acres)

Top of dam	58.9 (Estimated)
Maximum pool- design surcharge	99 (Estimated)
Recreation Pool	32.7

g. Dam

Type	Earthfill
Length	500 feet
Height	6.8 feet
Sideslopes - Upstream	Vertical
- Downstream	4 horiz. to 1 vert.
Zoning	Unknown
Impervious core	Unknown
Cutoff	Unknown
Grout curtain	Unknown

h. Diversion and Regulating Tunnel — N.A.

i. Spillway

Type	Broad crested weir
Length of weir - Primary	14.7 feet
- Secondary	73 feet
Crest elevation - Primary	108.7
- Secondary	109.0
Gates	N.A.
Approach channel	N.A.
Discharge channel	Stilling basin formed by steel sheet piling

j. Regulating Outlet

(Two) 2' x 3' low-level outlet sluice controlled by slide gate
Right elevation - 106.8
Left elevation - 105.5

SECTION 2: ENGINEERING DATA

2.1 Design

No plans or calculations pertaining to the original construction of the dam could be obtained. Drawings and calculations entitled "Plans for Proposed Reconstruction of Spillway at Lake Garrison" dated August 1958, relating to the construction of the present spillway structure which show plans of the spillway and appurtenant structures are available in the files of the NJDEP, Division of Water Resources.

Design calculations prepared in November 1940 show the spillway capacity at top of the dam to be 535 c.f.s. while the design flood peak flow was shown to be 491 c.f.s. based on the South Jersey Curve. Hydraulic analysis in Appendix 4 of this report indicated that the spillway could pass 614 c.f.s. at the top of the dam.

2.2 Construction

No data or reports pertaining to the original construction of the dam are available. Construction data or reports are limited to those on file with the NJDEP, Division of Water Resources.

2.3 Operation

Reportedly, no maintenance reports are on file with Lake Garrison, Inc. pertaining to the spillway and its appurtenant structures. No data pertaining to operations are available.

2.4 Evaluation

a. Availability

Available engineering data is limited to that which is on file with the NJDEP. These files contain plans and calculations relating to the present spillway structure and appurtenances.

b. Adequacy

Available engineering data pertaining to Lake Garrison Dam is of limited assistance to the performance of a Phase I evaluation. A list of absent information is included in paragraph 7.1.b.

c. Validity

The available hydraulic analyses appear to be valid with respect to engineering practice generally accepted in 1940. However, they are not valid according to analytic procedures developed by the Corps of Engineers for the present inspection and assessment program.

Although spillway discharge rates are in close agreement with values computed in connection with this Phase I Report, the design flood used in 1958 is not in conformance with the presently utilized SDF.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

The inspection of Lake Garrison Dam was performed on January 9, 1981 by staff members of Storch Engineers. A copy of the visual inspection check list is contained in Appendix 1. The following procedures were employed for the inspection:

1) The embankment of the dam, appurtenant structures and adjacent areas were examined.
2) The embankment and accessible appurtenant structures were measured and key elevations determined by surveyor's level.
3) The embankment, appurtenant structures and adjacent areas were photographed.
4) The immediate downstream flood plain was toured to evaluate downstream development and restricting structures.

b. Dam

The crest of the dam appeared to be fairly uniformly graded with some grass cover along the crest. Vehicle tracks observed along the crest gave evidence of an unpaved roadway used primarily for maintenance of the dam and its appurtenances.

The downstream face of the embankment appeared to be covered with briars, bushes, and trees. Trees ranged in size from 2 inches to 18 inches in diameter. Considerable erosion was observed adjacent to the right spillway abutment on the downstream face of the embankment, apparently due to surface runoff. The erosion had formed a gully approximately 30 inches deep and 18 inches wide. A timber wall braced by pipes had been constructed in the area of erosion in an attempt to stabilize the erosion.

The downstream face of the dam contained trees ranging in size from 1 inch to 8 inches in diameter. Additional larger trees were observed on the embankment near the spillway structure. These trees appeared to range from 24 to 36 inches in diameter.

The upstream face of the dam was composed of a timber bulkhead which was constructed of 2" X 6" timbers and braced by 6" X 6" and 2" X 6" timbers. The condition of the bulkhead appeared to be satisfactory. The level of the lake at the time of inspection was near the bottom of the bulkhead.

c. Appurtenant Structures

The spillway consisted of a horseshoe shaped weir with primary and secondary stage elevations. It was composed of interlocking steel sheet piles with a steel cap. A steel chain was also observed spanning the crest of the spillway apparently for protection of swimmers and boaters. The steel sheet piles were painted silver and appeared to be rusted in several locations with some scaling of the rust observed.

The operating mechanisms for the right and left gates appeared to be rusted but in generally satisfactory condition. The right gate was in the open (down) position at the time of inspection with water discharging through the outlet. The right sluice gate itself could not be properly observed due to the presence of discharge. The left gate was closed at the time of inspection but some discharge was observed leaking through the gate. The operating stem for the left gate appeared to be somewhat twisted and its operational adequacy could not be assessed.

The steel catwalks leading from the dam to the left and right gates appeared to be in satisfactory condition, although they were rusted. The interlocking steel sheet piles which form

the abutments of the spillway at the embankment continued along the upstream side of the embankment for approximately 12 feet, to junctions with the timber bulkhead.

The steel sheet pile abutments which form the spillway discharge channel were observed to be perpendicular to the dam. At the downstream end of the spillway discharge channel additional steel sheet piles forming a low weir across the discharge channel were located, thus forming a complete box of steel sheet piles. Concrete at the downstream end of the discharge channel poured against the sheet piling forming the low weir appeared to be in satisfactory condition. The timber bridge which spans the discharge channel appeared to be in satisfactory condition. The chain link fence located on the timber bridge also appeared to be in satisfactory condition.

d. Reservoir Area

The impoundment of the dam is approximately 2300 feet long with a width of approximately 800 feet. The right and left sides of the reservoir are lined with summer home sites. The complete shoreline along the left side and about half of the right side is lined with timber bulkheads and there are also docks along the shores. The bulkheads protrude about 3 feet above the water level at the time of inspection and the shores beyond have moderate slopes of about 5 or 6 percent. The shoreline at the upstream end is wooded with 3 foot high banks and flat to moderate slopes beyond the banks.

e. Downstream Channel

The left bank of the downstream channel is stabilized by a railroad tie wall immediately downstream from the dam. The wall appeared to be in satisfactory condition. County Route 553 crosses the downstream channel via County Road Bridge

9-J-1, located approximately 200 feet downstream from the dam. The bridge culvert opening measured 6.3 feet by 18.5 feet and appeared to be in generally good condition. A chain link fence located just upstream from the culvert runs across the stream and causes an obstruction. In addition, fallen trees were observed spanning the channel just downstream from the culvert. The remainder of the downstream channel appeared to be a natural stream with banks about one to two feet high with flat wooded terrain on both sides. Four summer homes are located immediately downstream from the toe of dam.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

The level of water in Lake Garrison is regulated by discharge over the interlocking steel sheet pile spillway. At the time of inspection the right outlet gate was open and was being used as the primary spillway.

The most recent drawdown of the lake occurred in September 1980 when the owner drew the lake down in order to maintain lake facilities.

Reportedly, the outlet works has been used in previous years at times of high water level to augment the spillway capacity. However, recent water levels have not been high enough to warrant that procedure.

4.2 Maintenance of the Dam

Reportedly, maintenance is performed on an "as needed" basis except for the cleaning of the bulkhead which is accomplished on a regular basis.

4.3 Maintenance of Operating Facilities

Reportedly, the lake is drawn down on a bi-yearly basis in order to facilitate repairs, as needed. Reportedly, the spillway structure was cleaned about 2 years ago.

4.4. Description of Warning System

Reportedly, no warning system is currently in use for the dam.

4.5 Evaluation of Operational Adequacy

The operation of the dam has been successful to the extent that the dam reportedly has not been overtopped since the spillway modification of 1958. However, the old dam reportedly overtopped in 1940.

Although maintenance has been good in some areas, some aspects of dam maintenance have not been adequately performed, including the following:

1) Gate stem of left sluice gate bent and not repaired.
2) Operating mechanisms for outlet works and steel sheet piling in rusted condition and protective paint not renewed.
3) Erosion adjacent to right abutment on downstream face of dam not repaired.
4) Trees on upstream and downstream sides of embankment not removed.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

The quantity of storm water runoff that the spillway should be able to handle is based on the size and hazard classification of the dam. This runoff quantity, called the spillway design flood (SDF) is described in terms of return frequency or probable maximum flood (PMF) depending on the extent of the dam's size and potential hazard. According to the "Recommended Guidelines for Safety Inspection of Dams" published by the U.S. Army Corps of Engineers, the SDF for Lake Garrison Dam falls in a range of 100-year frequency to 1/2 PMF. In this case, the low end of the range, 100-year frequency is chosen since the factors used to select size and hazard classification are on the low side of their respective ranges.

The SDF peak computed for Lake Garrison Dam is 3291 c.f.s. This value is derived from the 100-year flood hydrograph computed by the use of the HEC-1-DAM Flood Hydrograph Computer Program using the SCS Method. Hydrologic computations and computer output are contained in Appendix 4.

The spillway discharge rates were computed by the use of a weir formula appropriate for the configuration of the spillway structure. The total spillway discharge with lake level equal to the top of the dam was computed to be 614 c.f.s. The SDF was routed through the dam by use of the HEC-1-DAM computer program using the modified Puls Method. In routing the SDF, it was found that the dam crest would be overtopped by a depth of 1.3 feet. Accordingly, the subject spillway is assessed as being inadequate in accordance with criteria developed by the U.S. Army Corps of Engineers.

b. Experience Data

Reportedly, the dam has not been overtopped since its new spillway construction in 1958, but was overtopped during the flood of September 1, 1940.

An inspection report by the State of New Jersey in October 1940 indicated that the downstream bridge (Route 553) caused such high backwater that the dam was submerged during the flood of September 1, 1940.

Requests to increase the spillway capacity were denied until the capacity of the Route 553 bridge was increased. The increase was completed sometime after the 1940 flood.

c. Visual Observation

No evidence was found at the time of inspection that would indicate that the dam had been overtopped.

d. Overtopping Potential

As indicated in paragraph 5.1.a, a storm of magnitude equal to the SDF would cause overtopping of the dam by a depth of 1.3 feet over the crest of the dam. The spillway is capable of passing approximately 19 percent of the spillway design flood with the lake level equal to the top of dam.

e. Drawdown Time

Drawdown of the lake is accomplished by opening the right 24" x 36" sluice gate. Based on available information, the calculated drawdown time is estimated to be 4.6 days. (See Appendix 4)

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

The dam appeared, at the time of inspection to be outwardly structurally sound with no evidence of embankment cracks or distress. The erosion that was observed adjacent to the right abutment on the downstream face of the dam does not appear to be an indication of distress in the dam.

b. Generalized Soils Description

The generalized soils description of the site consists of recent alluvial deposits characterized by a poorly drained swampy condition overlying unconsolidated, stratified alluvial deposits consisting of interbedded silt, silty sand and silty and clayey sand and gravel.

c. Design and Construction Data

Analysis of structural stability and construction data for the embankment are not available.

d. Operating Records

No operating records are available for the dam. The water level of the impoundment of Garrison Lake is not monitored.

e. Post-Construction Changes

Reportedly, post-construction changes have been limited to the construction of the new spillway in 1958 which are on file with the NJDEP.

f. Seismic Stability

Lake Garrison Dam is located in Seismic Zone 1 as defined in "Recommended Guidelines for Safety Inspection of Dams" which is a zone of very low seismic activity. Experience indicates that dams in Seismic Zone 1 will have adequate stability under seismic loading conditions if they have adequate stability under static loading conditions. Lake Garrison Dam appeared to be stable at the time of inspection.

SECTION 7: ASSESSMENT AND RECOMMENDATIONS

7.1 Dam Assessment

a. Safety

Based on hydraulic and hydrologic analyses outlined in Section 5 and Appendix 4, the spillway of Lake Garrison Dam is assessed as being inadequate. The spillway is not able to pass the SDF without an overtopping of the dam.

The embankment appeared, at the time of inspection, to be generally outwardly stable.

b. Adequacy of Information

Information sources for this report include 1) field inspections, 2) USGS quadrangle, 3) consultation with personnel of Lake Garrison Inc. and 4) drawings and information on file with the NJDEP. The information obtained is sufficient to allow a Phase I assessment as outlined in "Recommended Guidelines for Safety Inspection of Dams."

Some of the absent data are as follows:

1. Description of fill material for embankment.
2. Soils report for the site.
3. Design report.
4. Maintenance documentation.

c. Necessity for Additional Data/Evaluation

Although some data pertaining to Lake Garrison Dam are not available, additional data are not considered imperative for this Phase I evaluation.

7.2 Recommendations

a. Remedial Measures

Based on hydraulic and hydrologic analyses outlined in paragraph 5.1.a, the spillway is considered to be inadequate. It is therefore recommended that a professional engineer experienced in the design and construction of dams be engaged in the near future to perform more accurate hydraulic and hydrologic analyses relating to spillway capacity. Based on the findings of these analyses, the need for and type of remedial measures should be determined and then implemented.

The owner should, in the near future, develop an emergency action plan together with an effective warning system outlining actions to be taken by the operator to minimize downstream effects of an emergency at the dam.

In addition, it is recommended that the following remedial measures be undertaken by the owner in the near future.

1) The rusted condition of outlet works operating mechanisms and steel sheet piling should be repaired.
2) Erosion of the embankment adjacent to the downstream right abutment should be properly filled and stabilized.
3) All trees and adverse vegetation on the embankment should be removed.

b. Maintenance

In the future, the owner of the dam should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

PLATES

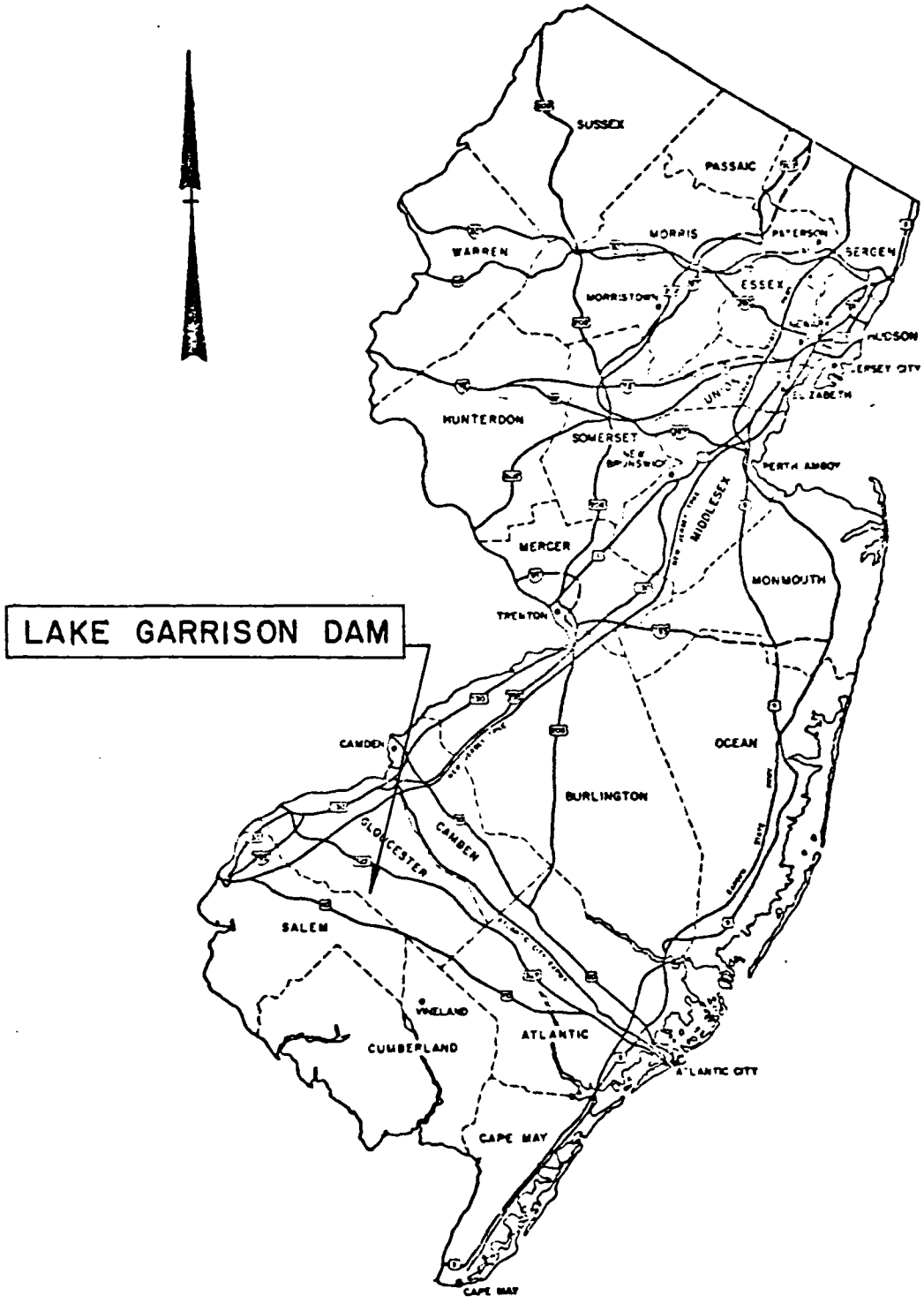
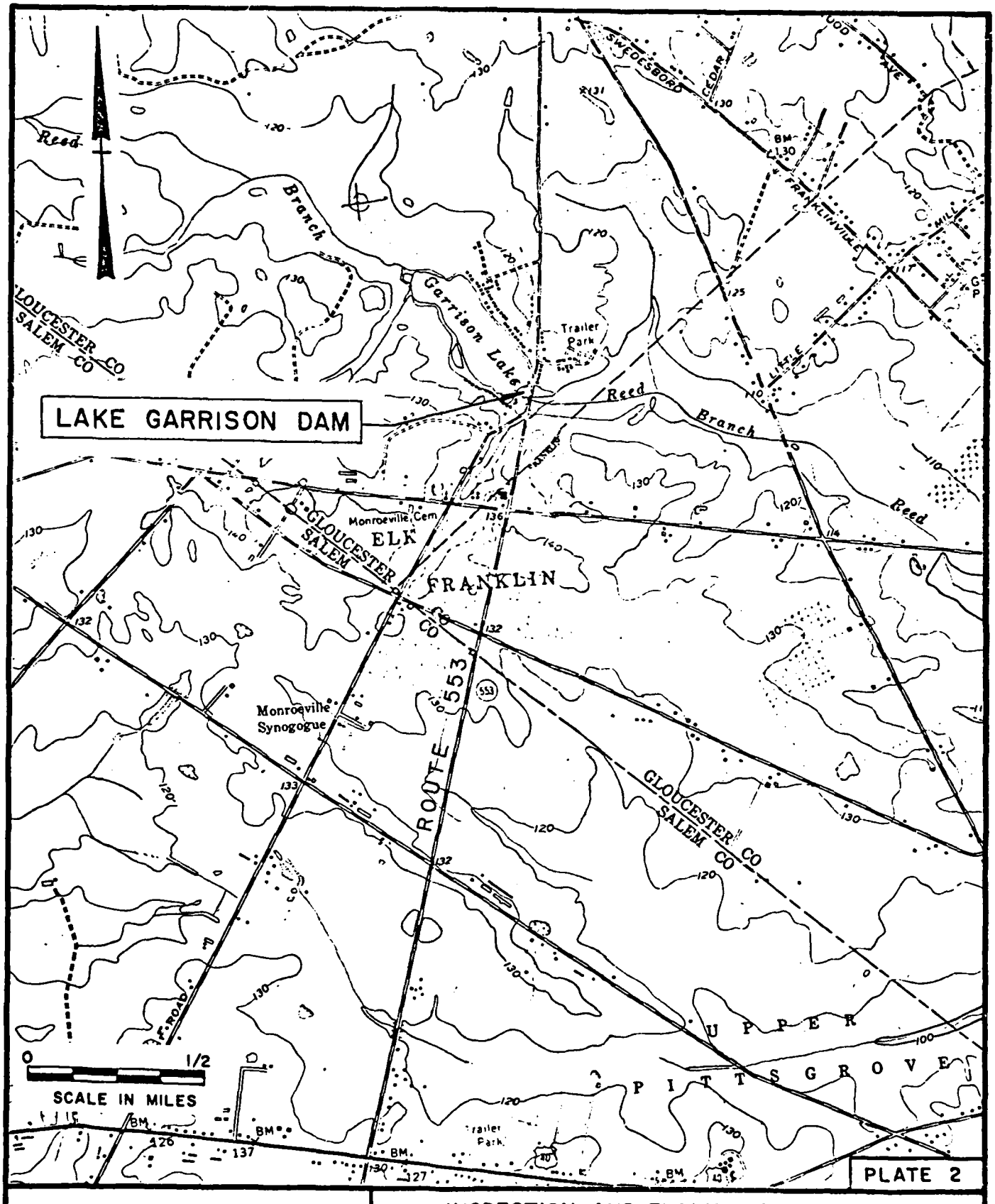


PLATE 1

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	INSPECTION AND EVALUATION OF DAMS KEY MAP LAKE GARRISON DAM
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY	SCALE: NONE DATE: FEB. 1981



STORCH ENGINEERS
FLORHAM PARK, NEW JERSEY

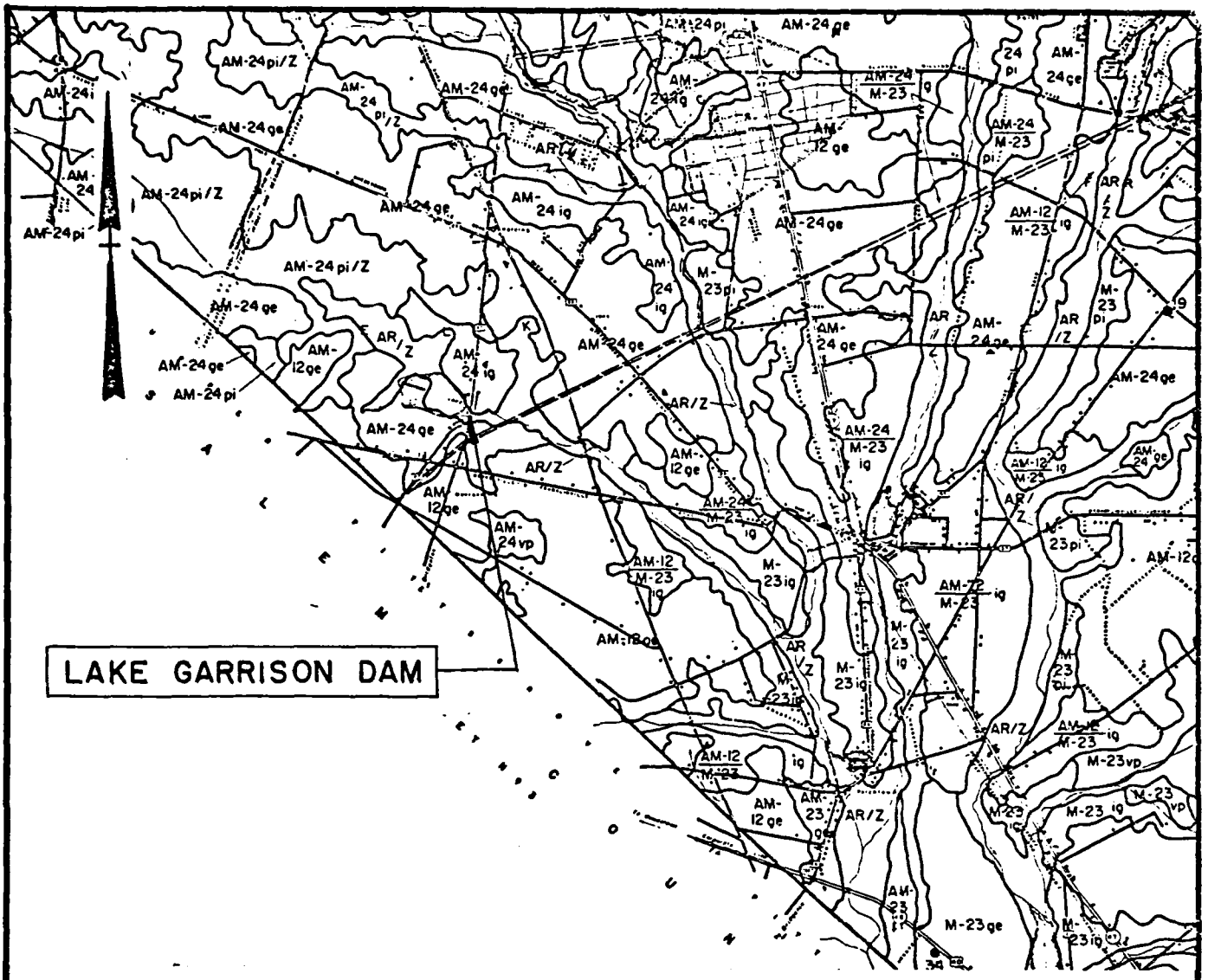
DIVISION OF WATER RESOURCES
N.J. DEPT. OF ENVIR. PROTECTION
TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

VICINITY MAP

LAKE GARRISON DAM

SCALE: AS SHOWN
DATE: FEB. 1981



Legend

AM-24	Unconsolidated stratified alluvial deposit.
AR/Z	Recent alluvial deposits characterized by a poorly drain swampy condition.
Note:	Information taken from Rutgers University, Soil Survey of New Jersey, Report No. 16, Gloucester County, March 1955 and Geologic Map of New Jersey prepared by J.V. Lewis and H. Kummel 1910-1912, revised by H.B. Kummel 1931 and M. Johnson 1950.

PLATE 3

STORCH ENGINEERS
FLORHAM PARK, NEW JERSEY.

DIVISION OF WATER RESOURCES
N.J. DEPT. OF ENVIR. PROTECTION
TRENTON, NEW JERSEY.

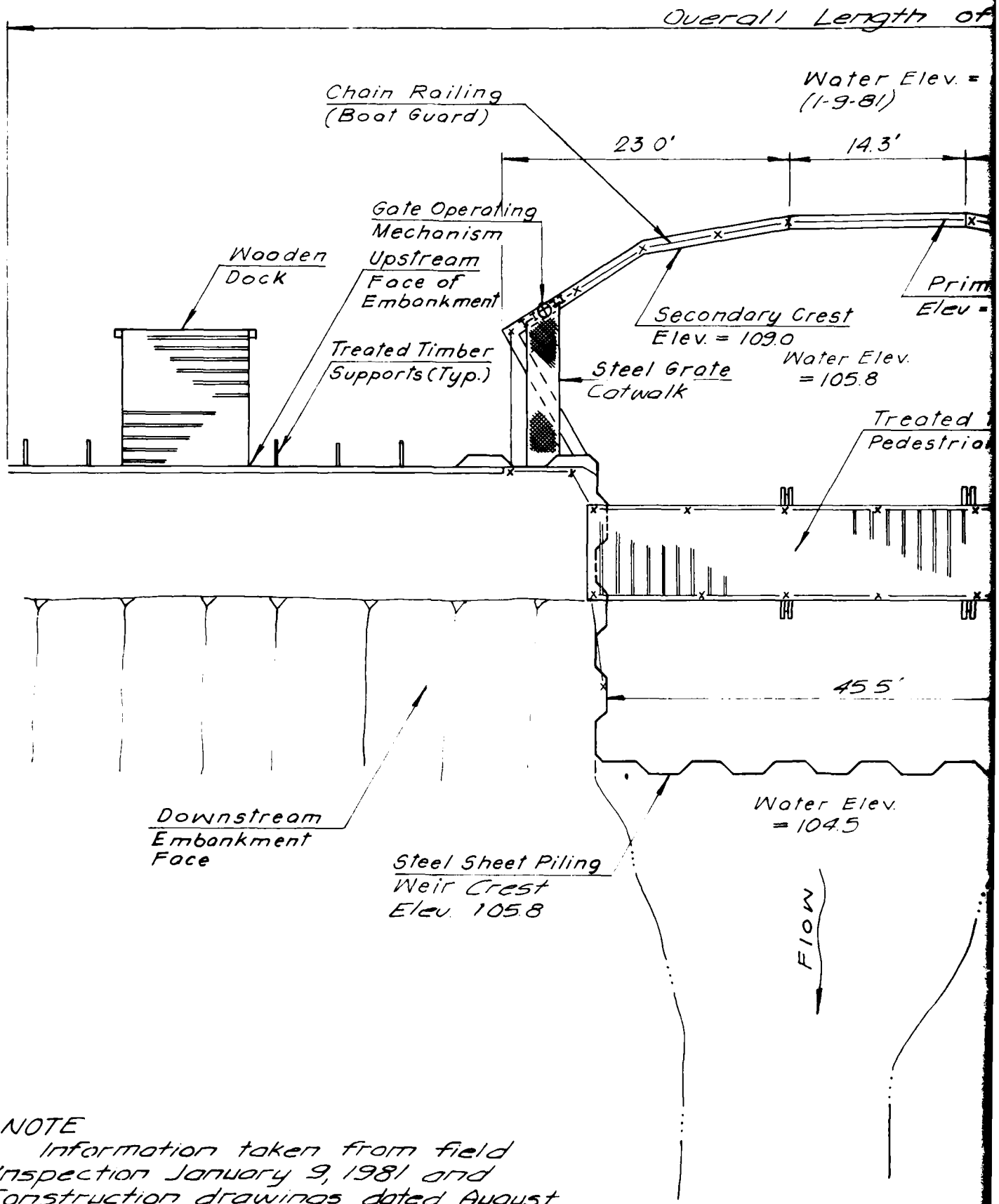
INSPECTION AND EVALUATION OF DAMS

SOIL MAP

LAKE GARRISON DAM

SCALE: NONE

DATE: FEB.1981



NOTE
Information taken from field Inspection January 9, 1981 and Construction drawings dated August 1958.

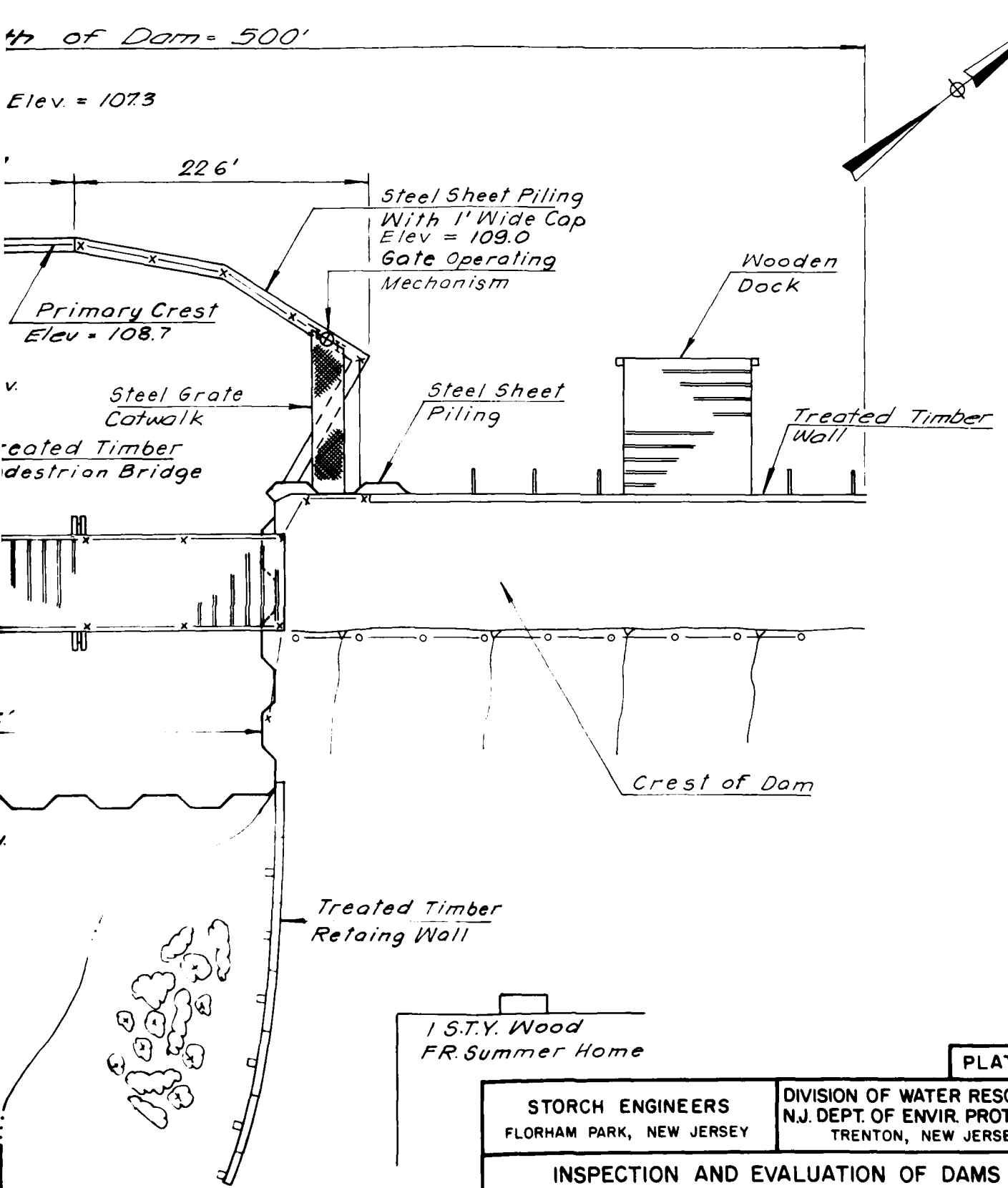


PLATE 4

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

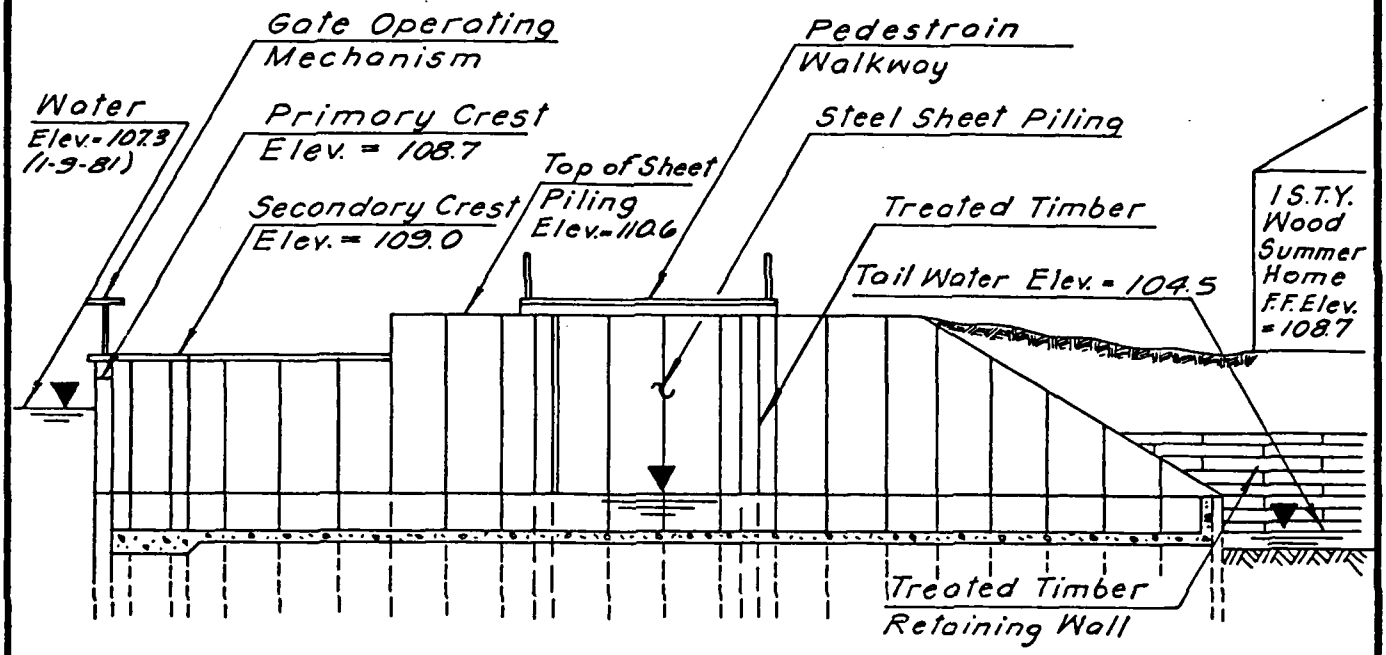
INSPECTION AND EVALUATION OF DAMS

GENERAL PLAN

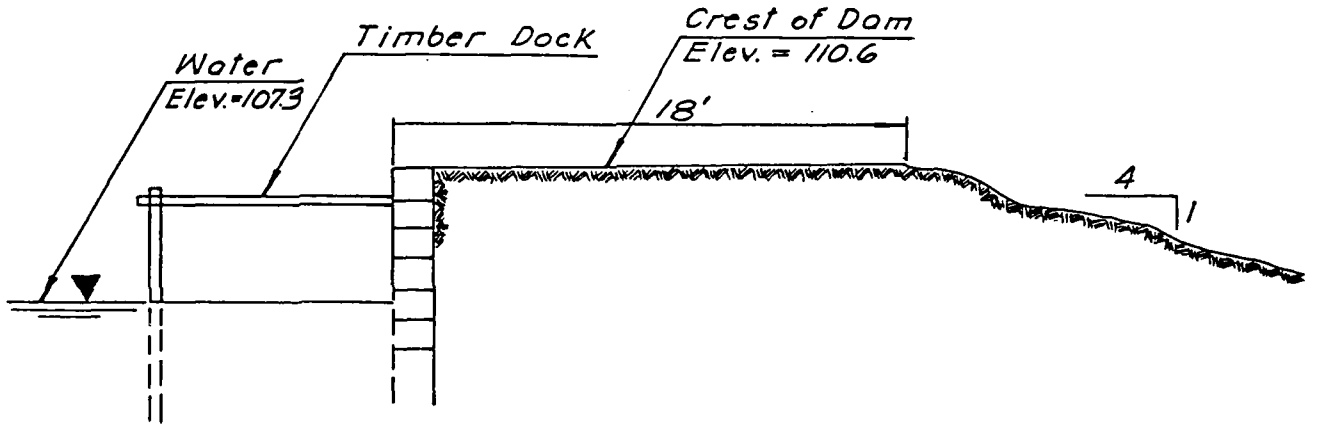
LAKE GARRISON DAM

I.D. N.J.00778	SCALE: NOT TO SCALE
	DATE: FEB. 1981

2



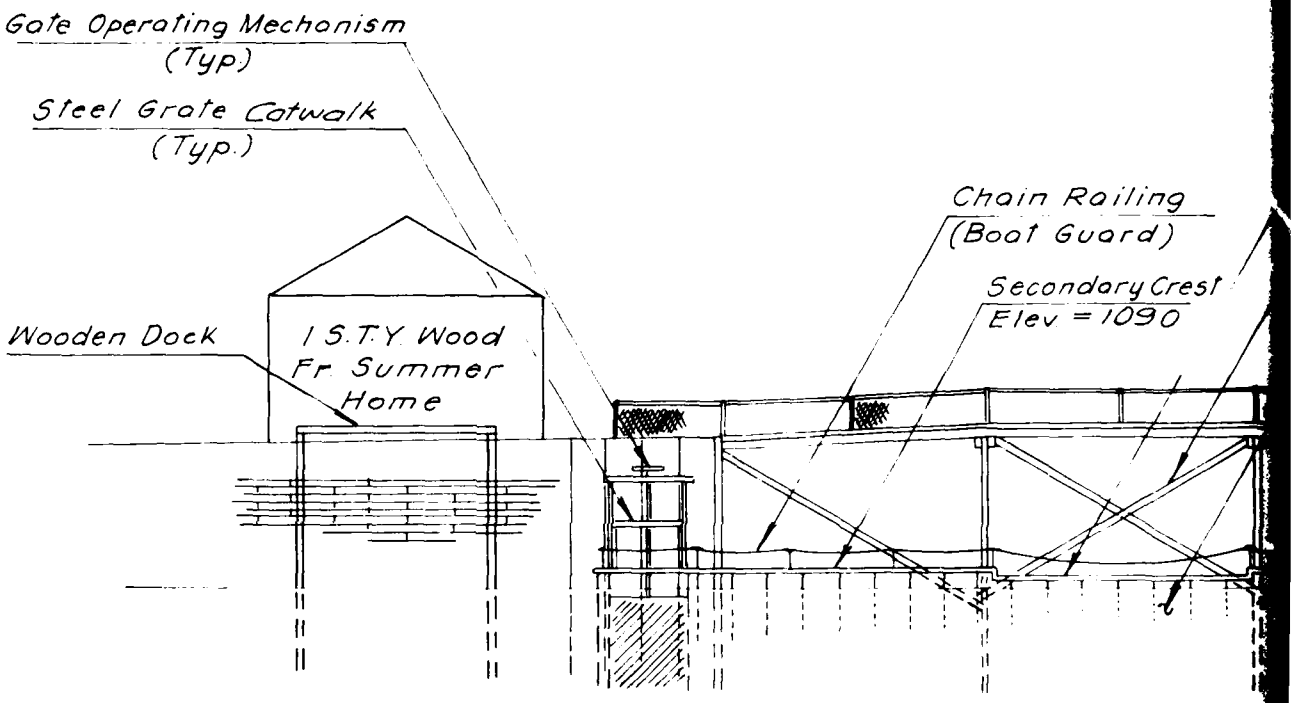
SPILLWAY SECTION



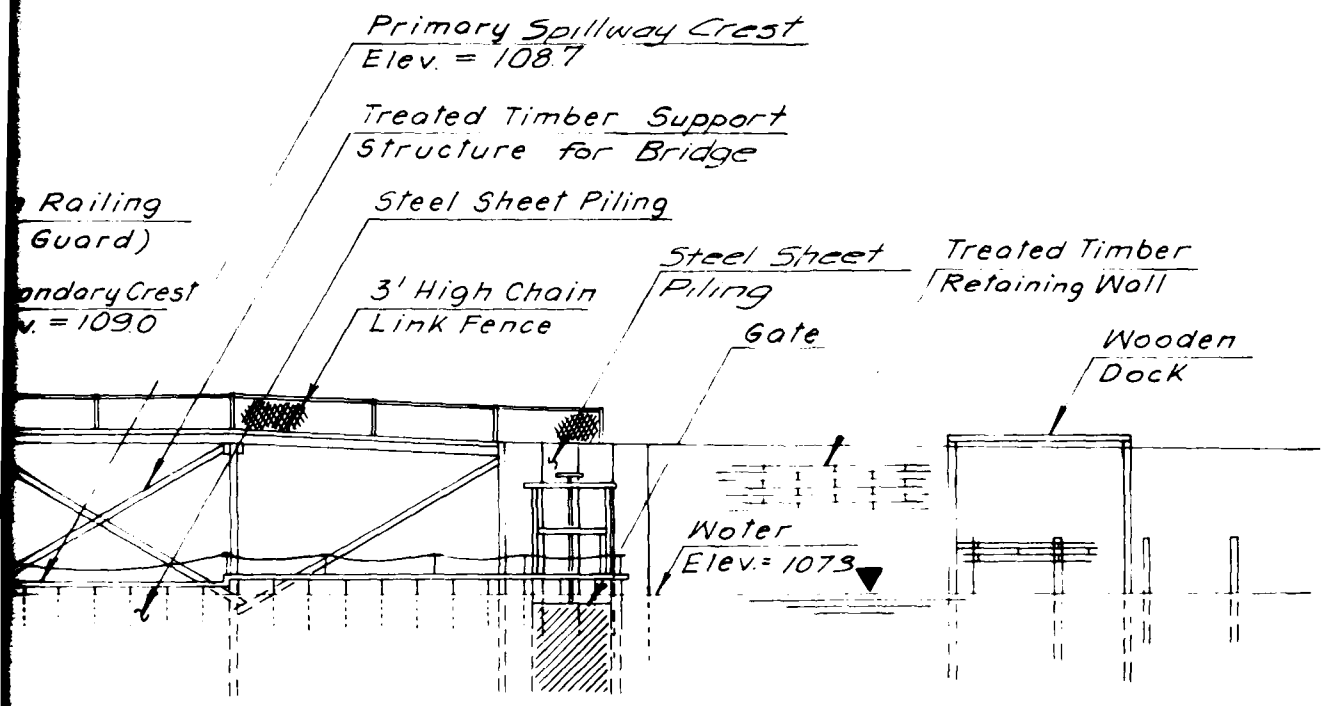
DAM SECTION

PLATE 5

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	INSPECTION AND EVALUATION OF DAMS SECTIONS LAKE GARRISON DAM
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY	I.D. N.J. 00778 / SCALE: AS SHOWN DATE: FEB. 1981


Gate Operating Mechonism
(Typ.)
Steel Grate Catwalk
(Typ.)
Chain Railing
(Boot Guard)
Secondary Crest
Elev = 1090
Wooden Dock
1 S.T.Y. Wood
Fr. Summer
Home

ELEVATION



LEVATION

PLATE 6

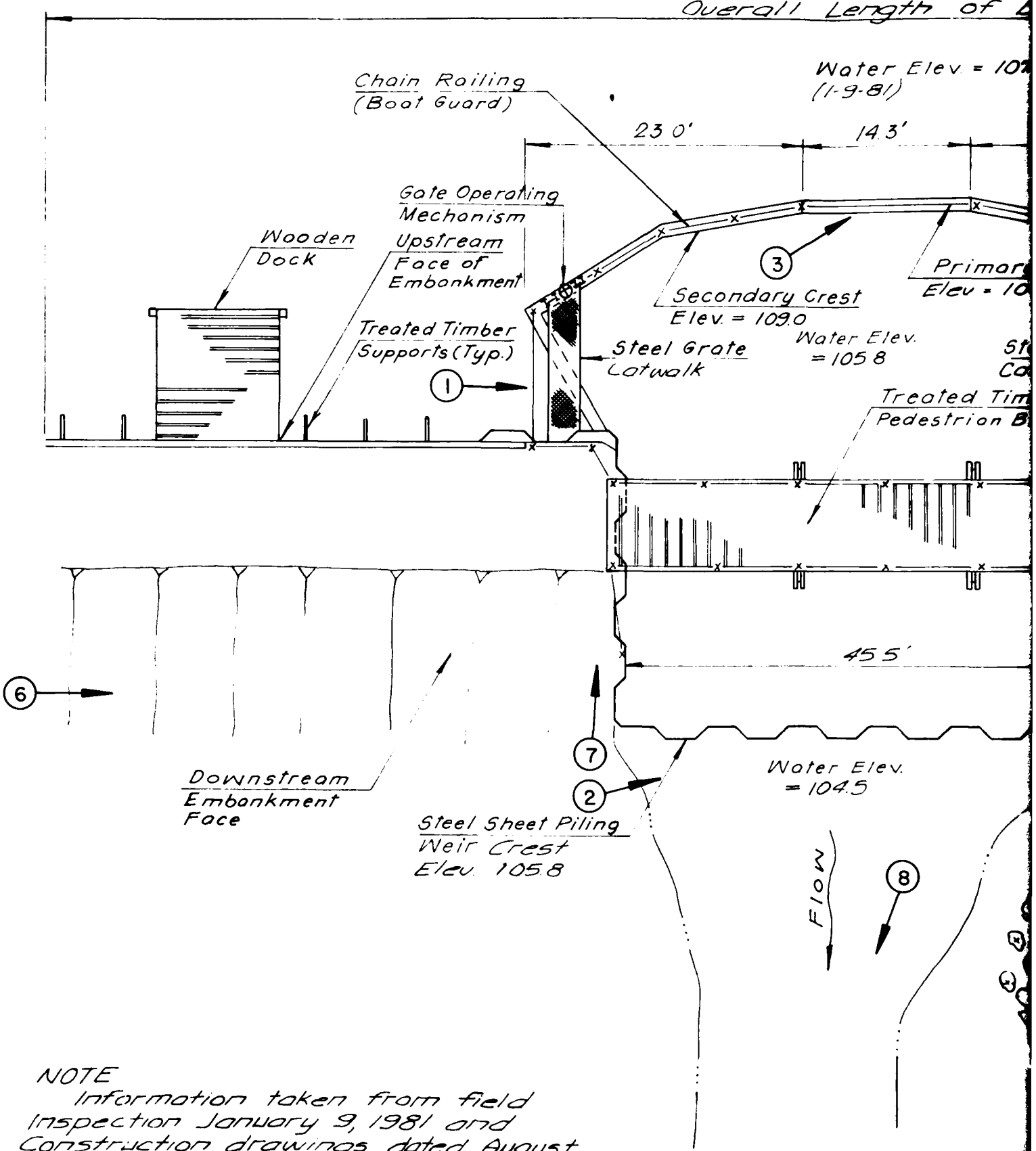
STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

UPSTREAM ELEVATION

LAKE GARRISON DAM

	SCALE: NOT TO SCALE
	DATE: FEB. 1981



NOTE
Information taken from field Inspection January 9, 1981 and Construction drawings dated August 1958

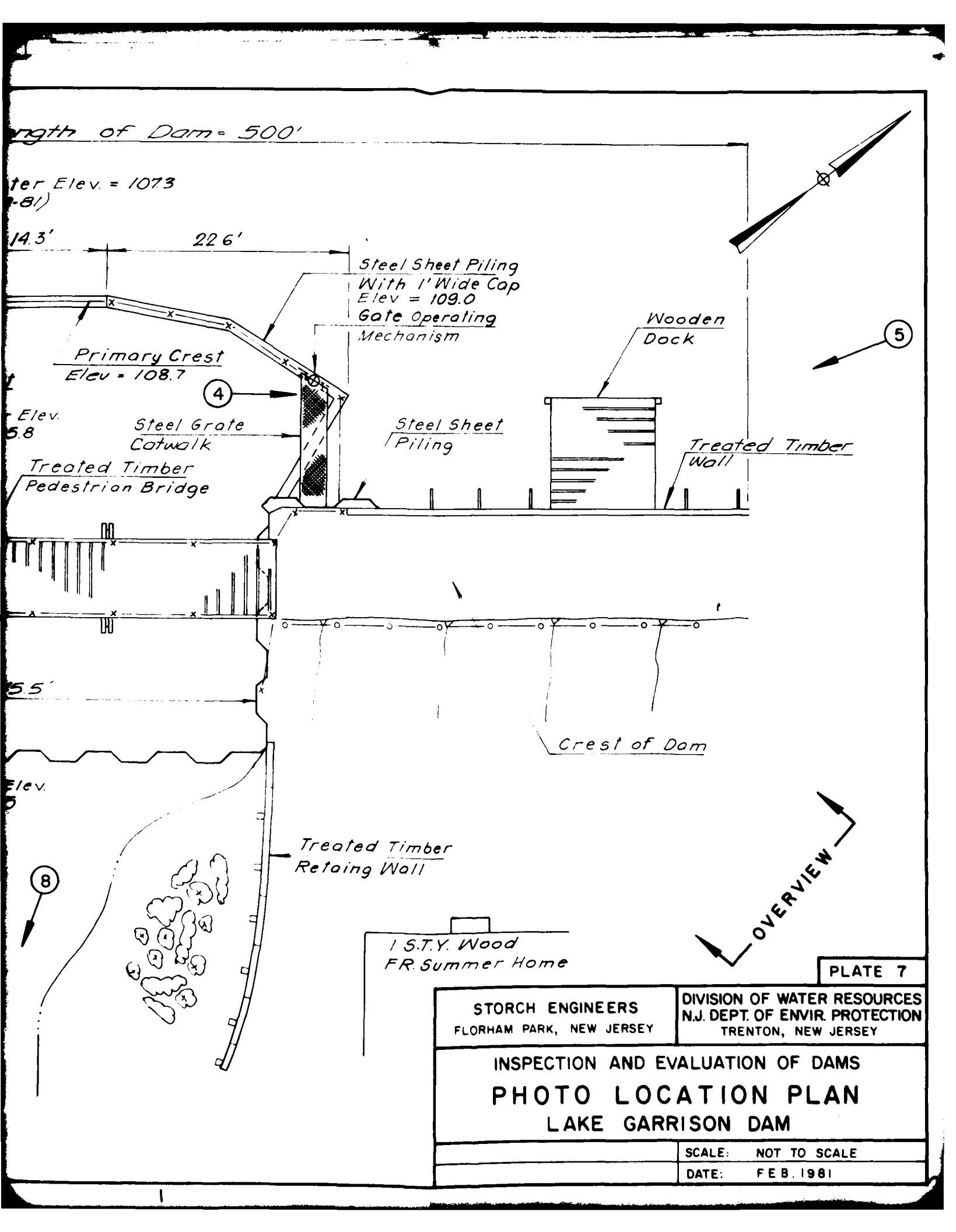


PLATE 7

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

PHOTO LOCATION PLAN

LAKE GARRISON DAM

	SCALE: NOT TO SCALE
	DATE: FEB. 1981

APPENDIX 1

Check List - Visual Inspection

Check List - Engineering Data

Check List

Visual Inspection

Phase I

Name of Dam Lake Garrison Dam County Gloucester State N.J. Coordinators NJDEP

Date(s) Inspection 1/9/81 Weather P. Cloudy Temperature 10°F.

Pool Elevation at time of Inspection 107.3 M.S.L. Tailwater at Time of Inspection 104.3 M.S.L.

Inspection Personnel:

John Gribbin John Powanda

Daniel Buckelew Richard McDermott

Mark Brady

John Gribbin Recorder

Present: Lynn Stetser, Sr., Manager, Lake Garrison Inc.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
GENERAL	Crest uniformly graded and unstabilized. Downstream side covered with briars, bushes and trees (2" to 36"). Upstream side formed by timber wall in satisfactory condition.	Crest should be stabilized. Trees and adverse vegitation should be removed.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Junction at left side of spillway appeared stable. Junction at right side of spillway significantly eroded. Erosion gully adjacent to spillway approx. 2.5' deep and 1.5' wide. Timber wall at upstream end of erosion appeared to be attempt to stabilize slope.	Eroded area should be filled and stabilized.
ANY NOTICEABLE SEEPAGE	None observed.	
STAFF GAGE AND RECORDER	None observed.	
DRAINS	None observed.	

EMBANKMENT

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Erosion observed adjacent to right side of spillway. (See "Junction")	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Vertical: level. Horizontal: straight.	
RIPRAP	None observed.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SURFACES IN OUTLET CONDUIT	N.A.	
INTAKE STRUCTURE	N.A.	
OUTLET STRUCTURE	N.A.	
OUTLET CHANNEL	Outlets discharge into stilling basin for spillway.	
GATE AND GATE HOUSING	Left gate, stem and slide channels rusted, with slight leakeage noted. Right gate operating mechanism rusted but appeared to be operational. Right gate opened at time of inspection. Steel catwalks to gates rusted but in generally satisfactory condition.	Left gate should be investigated for operational adequacy.

SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
WEIR	Weir formed by steel cap on interlocking steel sheet piling. Sheet piling appeared sound but rusted in places with protective paint peeling at the rust locations. Safety chain along weir appeared to be in satisfactory condition.	Steel piling should be protected against rust.
APPROACH CHANNEL	N.A.	
DISCHARGE CHANNEL	Weir discharges into stilling basin formed by steel sheet piling sides and a low weir at the downstream end. The low weir also formed by steel sheet piling. Steel sheet piling appeared sound but rusted in places.	Low weir and sides of stilling basin formed by continuation of sheet piling which forms weir.
BRIDGE	Timber bridge spanning stilling basin appeared to be in satisfactory condition.	

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None observed.	
OBSERVATION WELLS	None observed.	
WEIRS	None observed.	
PIEZOMETERS	None observed.	
OTHER		

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Shore slopes along left and right sides are moderate (5%-6%). Shore at upstream end has 3' banks and flat to moderate slopes beyond.	
SEDIMENTATION	Unknown.	
STRUCTURES ALONG BANKS	Right and left shores lined with homesites, most of which have timber walls forming the lake shore. Many include docks.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTION, DEBRIS, ETC.)	Between dam and road bridge about 200' downstream, channel is natural stream with portion of left bank stabilized by railroad tie wall. Chain link fence runs across stream immediately upstream from road bridge. Fallen trees observed in stream just downstream from bridge. Trees and fence comprise obstructions.	Debris should be removed. Fence should be removed from stream.
SLOPES	Banks 1' to 2' high with thickly wooded flat terrain on both sides.	
STRUCTURES ALONG BANKS	Four summer homes located along dam at toe. Two are right of spillway and two are left of spillway.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM			REMARKS
DAM	-	PLAN	Not Available
		SECTIONS	
SPILLWAY	-	PLAN	Drawings titled "Plans for Proposed Reconstruction of Spillway at Lake Garrison" dated August 1958, prepared by Frederick H. McClennen (2 sheets) available in NJDEP files. NJDEP, Division of Water Resources, P.O. Box CN-029, Trenton New Jersey 08625.
		SECTIONS	
		DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS			McClennen drawings, available in NJDEP files.
OUTLETS	-	PLAN	McClennen drawings, available in NJDEP files.
		DETAILS	
		CONSTRAINTS	
		DISCHARGE RATINGS	
HYDRAULIC/HYDROLOGIC DATA			Not Available
RAINFALL/RESERVOIR RECORDS			Not Available
CONSTRUCTION HISTORY			Not Available
LOCATION MAP			Available in NJDEP files.

ITEM	REMARKS
DESIGN REPORTS	Not Available
GEOLOGY REPORTS	Not Available
DESIGN COMPUTATIONS	
HYDROLOGY & HYDRAULICS	Hydraulic and hydrologic computations relating to spillway available in NJDEP files
DAM INSTABILITY	Not Available
SEEPAGE STUDIES	Not Available
MATERIALS INVESTIGATIONS	Not Available
BORING RECORDS	
LABORATORY	
FIELD	
POST-CONSTRUCTION SURVEYS OF DAM	Not Available
BORROW SOURCES	Correspondence in NJDEP files refers to soil used to repair damage resulting from 1940 flood.

ITEM	REMARKS
MONITORING SYSTEMS	Not Available
MODIFICATIONS	Spillway reconstructed in 1958.
HIGH POOL RECORDS	Not Available
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Limited inspection reports available in NJDEP files.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Dam damaged by flood of September 1940. Reports and correspondence in NJDEP files.
MAINTENANCE OPERATION RECORDS	Not Available

APPENDIX 2

Photographs

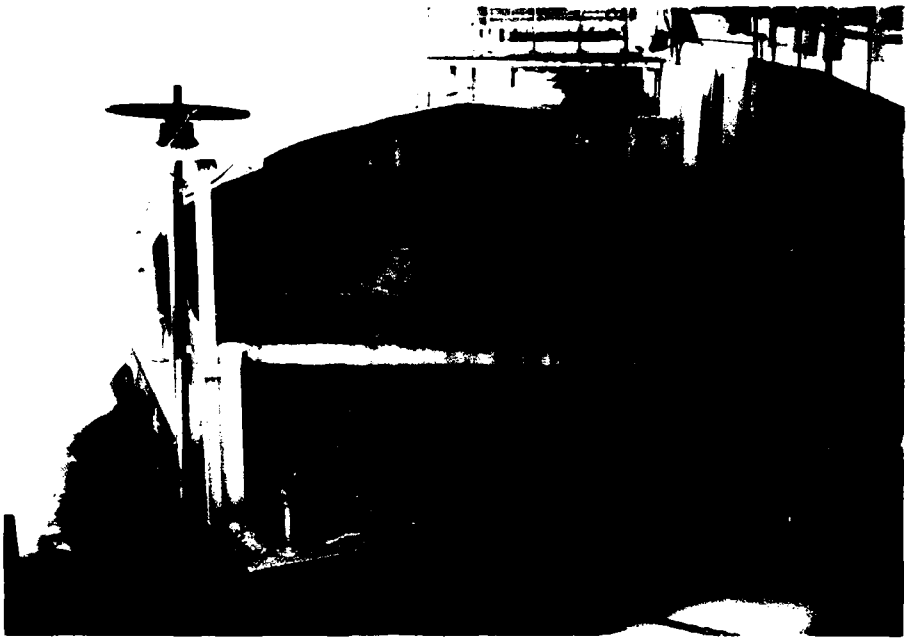


PHOTO 1
SPILLWAY

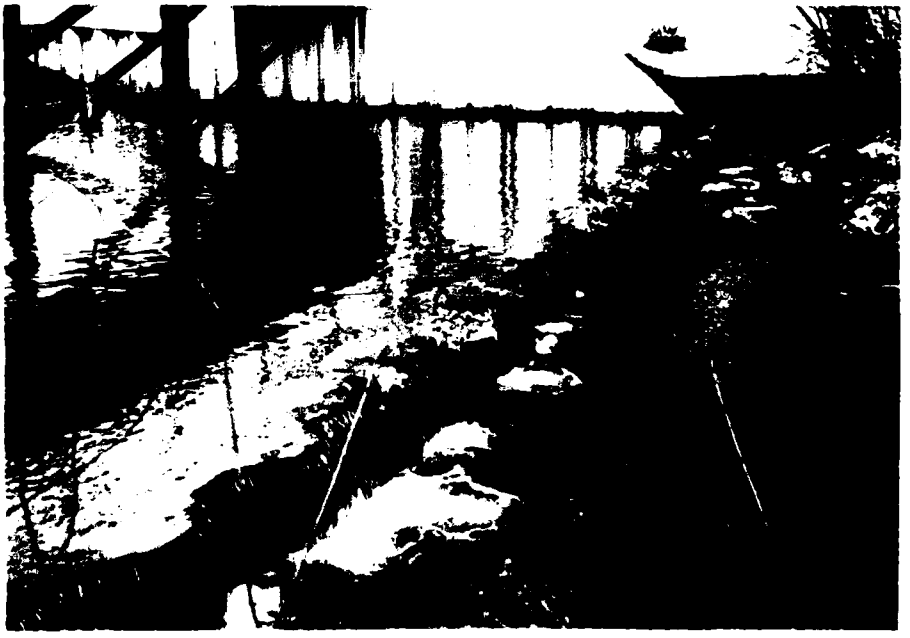


PHOTO 2
LOW WEIR AT DOWNSTREAM END OF STILLING BASIN

LAKE GARRISON DAM
9 JANUARY 1981

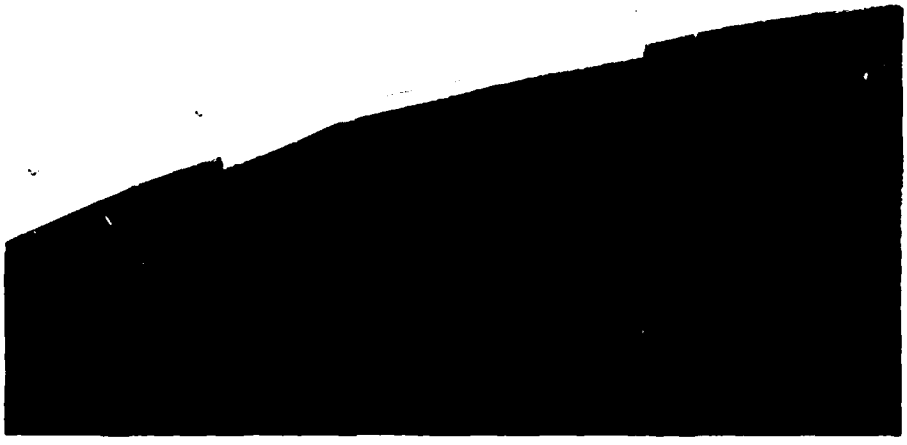


PHOTO 3
PRIMARY STAGE OF SPILLWAY CREST

PHOTO 4
LEFT END OF SPILLWAY CREST

LAKE GARRISON DAM
9 JANUARY 1981

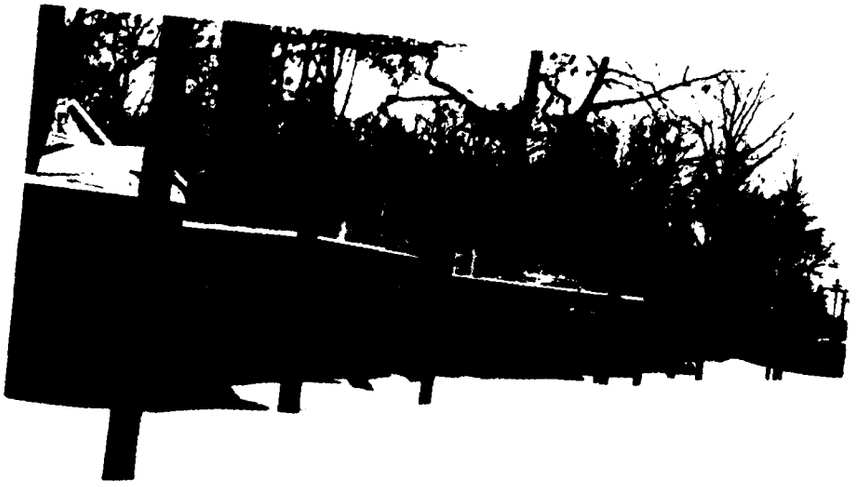


PHOTO 5
TIMBER WALL ON UPSTREAM SIDE OF DAM

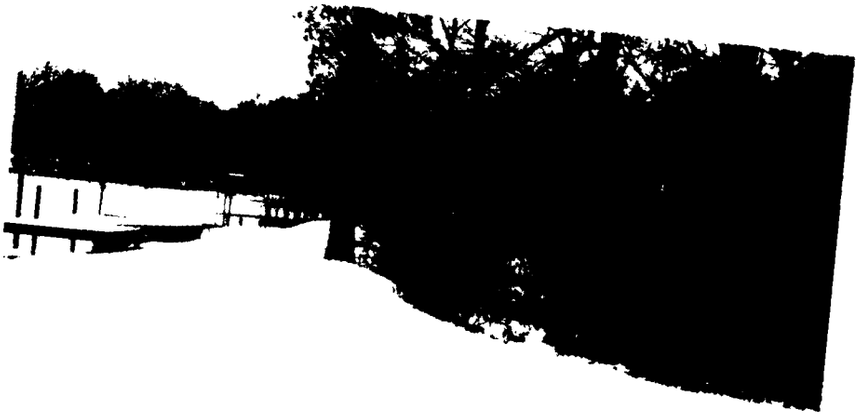


PHOTO 6
DOWNSTREAM SIDE OF DAM AT RIGHT END

LAKE GARRISON DAM
9 JANUARY 1981

PHOTO 7

EROSION AT JUNCTION BETWEEN EMBANKMENT
AND SPILLWAY STRUCTURE

PHOTO 8

DOWNSTREAM CHANNEL

LAKE GARRISON DAM

9 JANUARY 1981

APPENDIX 3

Engineering Data

CHECK LIST

HYDROLOGIC AND HYDRAULIC DATA

ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Partially wooded, swampy

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 108.8 (89 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N.A.

ELEVATION MAXIMUM DESIGN POOL: 111.9

ELEVATION TOP DAM: 110.6

SPILLWAY CREST:

a. Elevation 108.7 (Primary), 109.0 (Secondary)

b. Type Broad crested weir

c. Width 1.0 ft.

d. Length 14.7 ft (Primary), 73 ft. (Secondary)

e. Location Spillover Upstream side of dam

f. Number and Type of Gates None

OUTLET WORKS: Two slide gates

a. Type Steel 2' x 3' slide gates

b. Location Left and right ends of spillway structure

c. Entrance Invert N.A.

d. Exit Invert 105.5 (left), 106.8 (right)

e. Emergency Draindown Facilities: Open right gate

HYDOMETEOROLOGICAL GAGES: None

a. Type N.A.

b. Location N.A.

c. Records N.A.

MAXIMUM NON-DAMAGING DISCHARGE:

(Lake Stage Equal to Top of Dam) 614 c.f.s.

APPENDIX 4

Hydraulic/Hydrologic Computations

HYDROLOGY :

HYDROLOGIC ANALYSIS

THE RUNOFF HYDROGRAPH WILL BE DEVELOPED BY THE HEC-1-DAM COMPUTER PROGRAM USING THE SCS METHOD WITH CURVILINEAR TRANSFORMATION

DRAINAGE AREA = 7.0 SQ MI

INFILTRATION DATA

INITIAL INFILTRATION = 1.5 IN

CONSTANT INFILTRATION = 0.15 IN/HOUR

TIME OF CONCENTRATION

1. [by SCS-TR 55]

OVERLAND FLOW:

LENGTH	=	3,000	[Ft]
AVE. SLOPE	=	0.7	[%]
ΔH = 161' − 140' = 21'			
AVE. VELOCITY	=	0.21	[Fps]

CHANNEL FLOW:

LENGTH	=	19,500	[Ft]
AVE. SLOPE	=	0.16	[%]
ΔH = 140' − 109' = 31'			
AVE. VELOCITY	=	1.32	[Fps]

$$T_c = \left[\left(\frac{3000}{0.21}\right) + \left(\frac{19500}{1.32}\right)\right]\frac{1}{3600} = 3.97 + 4.1$$

$T_c = 8.1$ Hr

2. ['Handbook of applied hydrology' by Chau, Pg. 14-36]

$$T_c = \sqrt[2.14]{\frac{2/3\, L\eta}{\sqrt{s}}}$$

$$T_c = \sqrt[2.14]{\frac{2/3\,(3000 \times 0.4)}{\sqrt{0.007}}}$$

T_c = time of concentration [min]

s = slope [%]

η = 0.4 roughness coefficient

L = length of overland flow [Ft]

$T_c = 72.1$ min

$T_c = 1.2 + 4.1 = 5.3$ Hr

3. [by "Design of small dams", Pg 71]

$$T_C = \left(\frac{11.9 (L)^3}{H}\right)^{0.385}$$

T_C = time of concentration [Hr]

L = Longest water course [Mi]

H = elev. difference

$$T_C = \left(\frac{11.9 \times 4.26^3}{52}\right)^{0.385}$$

$L = 4.26$ [Mi]

$H = 52$ [Ft]

$T_C = 3.0$ Hr

COMPUTER INPUT

$T_C = 6.5$ Hr LAG = 60%

LAG Time = 3.9 Hr.

PRECIPITATION

24 HOURS, 100-YEAR RAINSTORM

DISTRIBUTION FOR LAKE GARRISON DAM

TIME [Hr]	RAIN [IN]
1	.08
2	.08
3	.08
4	.08
5	.08
6	.08
7	.09
8	.09
9	.18
10	.18
11	.18
12	.19
13	.30
14	.30
15	.80
16	3.00
17	.40
18	.30
19	.19
20	.18
21	.09
22	.09
23	.08
24	.08
24 [Hr]	Σ 7.2 [IN]

FROM U.S. WEATHER BUREAU Tp. 40

STORCH ENGINEERS

Sheet 5 of 11

Project 1132-06 LAKE GARRISON DAM

Made By JiHa Date 3-24-81

Chkd By JG Date 4/10/81

LAKE STORAGE VOLUME

W.L. ELEV. [Ft]	AREA [Acres]
103.8	0
107.3	30.0
109.0	33.0
110.0	40.4
120.0	348.0

HEC-1-DAM COMPUTER PROGRAM WILL DEVELOP STORAGE CAPACITY FROM WATER SURFACE AREAS & ELEVATIONS. INFORMATION TAKEN FROM U.S.G.S. QUAD-RANGLE Pitman West & East, Elmer, Newfield, N.J.

HYDRAULICS

SPILLWAY SECTION

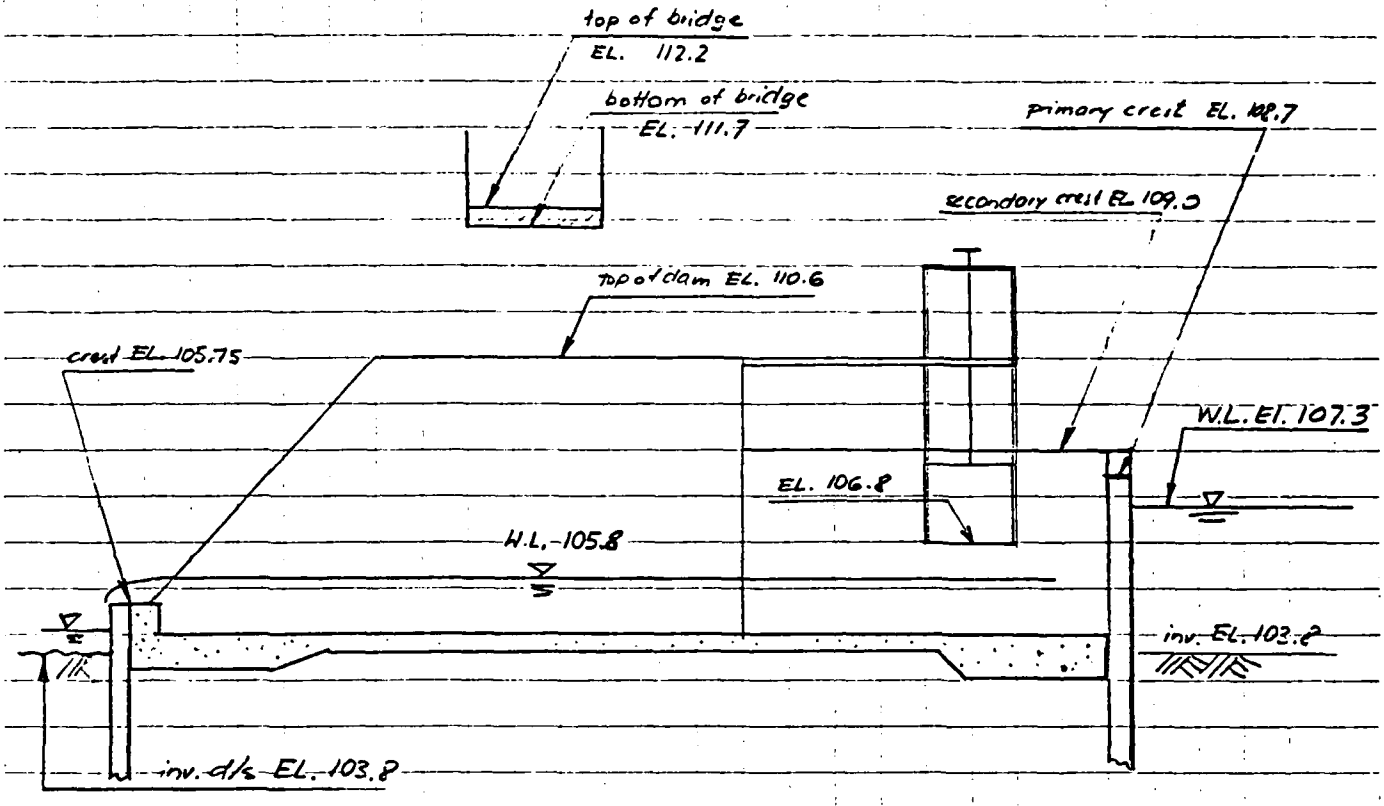
THE SPILLWAY AT LAKE GARRISON DAM CONSISTS OF A STEEL HORSESHOE, FREE OVERFLOW SPILLWAY WITH A PRIMARY WEIR AT ELEV. 108.7 FEET AND A SECONDARY WEIR AT ELEV. 109.0 FEET

ON THE LEFT AND RIGHT SIDE OF SPILLWAY ARE TWO (2) RECTAGULAR SLUICE GATES 24" x 36", THE LEFT GATE CREST IS AT ELEV. 105.5 FEET AND THE RIGHT GATE CREST IS AT ELEV. 106.8 FEET

Project 1132-06 LAKE GARRISON DAM Made By J.Ha Date 3-25-81

Chkd By JG Date 4/10/81

SECTION:



[Handbook of hydraulics, Pg 5-23]

THE DISCHARGE OF PRIMARY CREST AT ELEV. 108.7 FEET AND OF SECONDARY CREST AT ELEV. 109.0 FEET WILL BE CALCULATED USING FORMULA:

$$Q = C L H^{3/2}$$

Q - discharge [cfs]
C - coefficient of discharge
L - eff. length of spillway [Ft]
H - total head on spillway [Ft]

SPILLWAY

STAGE DISCHARGE TABULATION

W.L. ELEV. [Ft]	SPILLWAY PRIMARY CREST EL. 108.7 L = 14.7' H [Ft]	C	Q [cfs]	SECONDARY CREST EL. 109.0 L = 73' H [Ft]	C	Q [cfs]	Total Q
108.7	—	—	—				—
109.0	.3	2.77	7	—	—	—	7
109.5	.8	3.04	32	.5	2.84	73	105
110.0	1.3	3.23	70	1.0	3.14	229	299
110.6	1.9	3.32	128	1.6	3.29	486	614
111.0	2.3	3.32	170	2.0	3.31	683	853
111.7	3.0	3.32	254	2.7	3.32	1075	1329

STORCH ENGINEERS

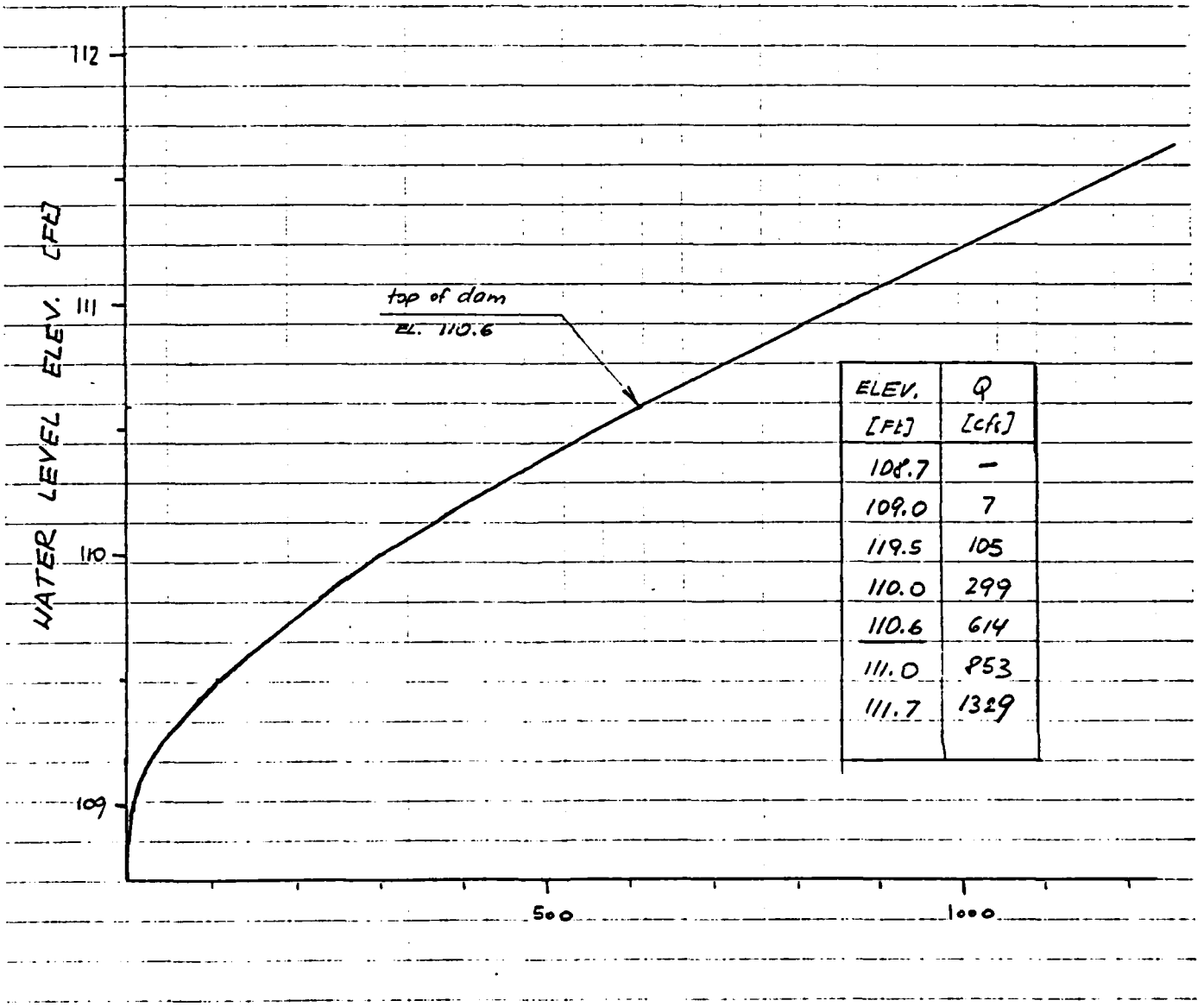
Sheet 9 of 11

Project 1132-06 LAKE GARRISON DAM

Made By JHQ Date 3-25-81

Chkd By JG Date 4/10/81

SPILLWAY
STAGE DISCHARGE CURVE



ELEV. [FT]	Q [cfs]
108.7	–
109.0	7
119.5	105
110.0	299
110.6	614
111.0	853
111.7	1329

DRAWDOWN:

[Handbook of hydraulics, Pg 4-9]

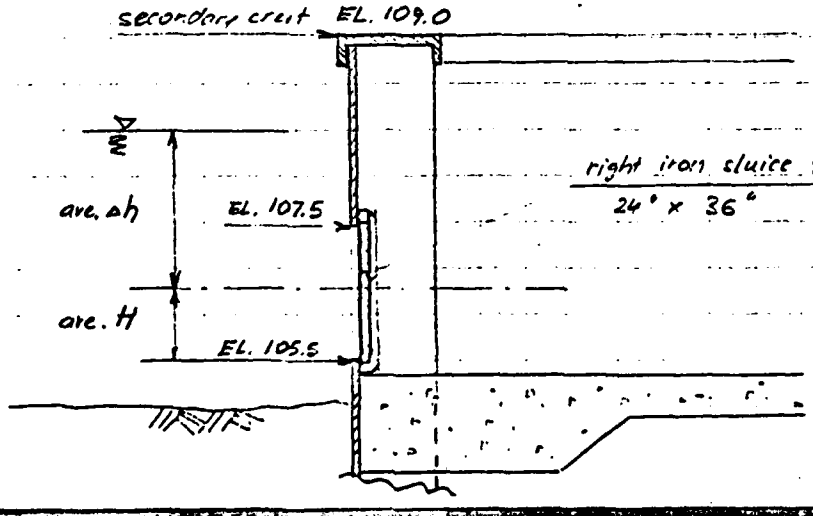
THE DISCHARGE OF DRAWDOWN WILL BE CALCULATED FOR RIGHT SLUICE GATE 24' x 36" AT EL. 105.5 FEET IN TWO STAGES.

FOR DISCHARGE FROM EL. 107.5 AND ABOVE USING AVE. HEAD $\Delta h = 2.0$ FEET AND FORMULA : $Q = Ca\sqrt{2g\Delta h}$

[Handbook of hydraulics, Pg 5-9]

FOR DISCHARGE FROM EL. 105.5 FEET TO ELEV. 107.5 FEET USING AVE. HEAD $H = 1.0$ FEET AND FORMULA :

$Q = CLH^{3/2}$



$\Delta h = 2.0'$
$a = 6.0\ Ft^2$

right iron sluice gate 24" x 36"
$H = 1.0'$
$L = 3.0'$

$Q_1 = Ca\sqrt{2gsh}$

$Q_1 = 0.6 \times 6.0 \times \sqrt{64.4 \times 2.0}$

$Q_1 = 41$ cfs

Q - discharge [cfs]
C - coefficient 0.6
a - area of discharge [Ft²]
g - 32.4
sh - head to centroid [Ft]

$Q_2 = CLH^{3/2}$

$Q_2 = 2.6 \times 3.0 \times 1.0^{1.5}$

$Q_2 = 8$ cfs

Q - discharge [cfs]
C - coefficient 2.6
L - length of spillway [Ft]
H - total head on spillway [Ft]

TIME OF DRAWDOWN

$$Td = \frac{\text{Storage [Acft]}}{\text{Ave. Q} - \text{Inflow [cfs]}} \times \frac{43560}{3600}$$

Assume inflow 4.0 cfs

Ave. Q_1 = 41 cfs

Storage at W.L. EL. 109.0 = 89.0 [Acft]
Storage at W.L. EL. 107.5 = -30.0 [Acft]
59.0

$$Td_1 = \frac{59.0}{41 - 4} \times \frac{43560}{3600} = 19.3 \text{ Hr.}$$

Ave. Q_2 = 10 cfs

Storage at W.L. EL. 107.5 = 30.0 [Acft]

$$Td_2 = \frac{30.0}{8 - 4} \times \frac{43560}{3600} = 90.8 \text{ Hr.}$$

$Td_1 + Td_2 = 19.3 + 90.8 = 110$ Hr. (4.6 days)

HEC - 1 - DAM PRINTOUT

Overtopping Analysis

```
1A1
 A2 LAKE GARRISON        NATIONAL DAM SAFETY PROGRAM
                         [redacted] DAM, NEW JERSEY
 A3                      100 YEAR STORM ROUTING
 B     150        0      15                                                  4
 B1      5
 J       1        1       1
 J1      1
 K       0     LAKE                                          1
 K1                      INFLOW HYDROGRAPH TO [redacted] DAM
 M       0        2    7.0              7.0
 O      96
 O1  0.019    0.019    0.019    0.019    0.019    0.019    0.019    0.019    0.019    0.019
 O1  0.019    0.019    0.019    0.019    0.019    0.019    0.019    0.019    0.019    0.019
 O1  0.019    0.019    0.019    0.019    0.019    0.019    0.019    0.019    0.019    0.019
 O1  0.019    0.019    0.019    0.019    0.019    0.019    0.019    0.019    0.019    0.019
 O1  0.019    0.019    0.019    0.019    0.019    0.019    0.019    0.019.   0.038    0.038
 O1  0.038    0.038    0.038    0.038    0.038    0.038    0.038    0.038    0.038    0.038
 O1  0.083    0.083    0.083    0.083    0.163    0.163    0.163    0.163    0.750    0.750
 O1  0.750    0.750    0.163    0.163    0.163    0.163    0.083    0.083    0.083    0.083
 O1  0.083    0.083    0.083    0.083    0.038    0.038    0.038    0.038    0.038    0.038
 O1  0.038    0.038    0.038    0.038    0.038    0.038
 T                                                        1.5     0.15
 W2              3.9
 X    -1.0    -0.05     2.0
 K       1     DAM
 K1                      ROUTE DISCHARGE THROUGH DAM
 Y                                    1        1
 Y1      1                                                -109.0      -1
 Y4  108.7    109.0    109.5    110.0    110.6    111.0    111.7
 Y5      0        7      105      299      614      853     1329
 $A      0       30       33     40.4      348
 $E  103.8    107.3    109.0    110.0    120.0
 $$  108.7
 $D  110.6     2.55      1.5      455
 K       1        1
 K1                      CHANNEL REACH ROUTING 1
 Y                                    1        1
 Y1      1
 Y6    0.1    0.055      0.1    101.5      111      200   0.0115
 Y7      0      111       80      107      160      103      162    101.5      172    101.5
 Y7    174      103      254      107      334      111
 K       1        2
 K1                      CHANNEL REACH ROUTING 2
 Y                                    1        1
 Y1      1
 Y6    0.1    0.055      0.1    100.5      110     3800  0.00026
 Y7      0      110      200      106      400      102      402    100.5      415    100.5
 Y7    417      102      817      106     1017      110
 K      99
```

NATIONAL DAM SAFETY PROGRAM

LAKE GARRISON [redacted] DAM, NEW JERSEY

100 YEAR STORM ROUTING

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	0	15	0	0	0	0	0	4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 1 NRTIO= 1 LRTIO= 1

RTIOS= 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH TO [redacted] DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
LAKE	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	2	7.00	0.00	7.00	0.00	0.000	0	0	0

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.50	.15	0.00	0.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= 3.90

RECESSION DATA

STRTQ= -1.00 QRCSN= -.05 RTIOR= 2.00

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
0									SUM	7.12	4.33	2.79	78875.
										(181.)	(110.)	(71.)	(2233.49)

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE DISCHARGE THROUGH DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM	1	0	0	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-109.	-1

STAGE	108.70	109.00	109.50	110.00	110.60	111.00	111.70
FLOW	0.00	7.00	105.00	299.00	614.00	853.00	1329.00
SURFACE AREA=	0.	30.	33.	40.	348.		
CAPACITY=	0.	35.	89.	125.	1815.		
ELEVATION=	104.	107.	109.	110.	120.		

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
108.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
110.6	2.6	1.5	455.

PEAK OUTFLOW IS 3250. AT TIME 22.00 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1
				1.00
HYDROGRAPH AT	LAKE	7.00 (18.13)	1	3291. (93.19)(
ROUTED TO	DAM	7.00 (18.13)	1	3250. (92.03)(
ROUTED TO	1	7.00 (18.13)	1	3249. (92.01)(
ROUTED TO	2	7.00 (18.13)	1	2816. (79.74)(

1

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	109.00	108.70	110.60
STORAGE	89.	79.	152.
OUTFLOW	7.	0.	614.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	111.92	1.32	235.	3250.	8.50	22.00	0.00

PLAN 1 STATION 1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	3249.	108.8	22.00

PLAN 1 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	2816.	109.6	23.25

APPENDIX 5

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